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Towards an Improved Understanding of Simulated and Observed Changes in Extreme Precipitation

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Abstract: In its most recent assessment of the science of climate change, the Intergovernmental Panel on Climate Change (IPCC) concluded that it is likely that increases in the frequency of heavy precipitation events have occurred in the late 20th century. They further concluded that it is more likely than not that human-induced climate change is responsible for these increases, and that future changes are very likely as the climate continues to warm.

Extreme precipitation events occur when the atmospheric circulation causes water vapor to strongly converge over a region. Thus a simple hypothesis that has been offered to explain the observed and projected increases in the frequency of heavy precipitation events in a warming world is that circulation changes are small and the increased water content of a warmer atmosphere is the driving mechanism. If this were true, the magnitude of extreme precipitation events would increase at a rate constrained by the Clausius-Clapeyron equation, or $\sim 7\%$ K⁻¹ of warming.

The goal of the proposed research is to better understand the physical mechanisms that underlie the near-ubiquitous increase in the frequency of extreme precipitation events that emerges from global warming simulations and also appears to be occurring in the real climate system. Some specific objectives are (1) to quantify the changes in the frequency and intensity of extreme daily precipitation events in a multi-model ensemble of climate model projections of future climate change and late 20th-century observations, (2) to determine how closely these changes conform to the 7% K⁻¹ scaling that would be expected from the Clausius-Clapeyron equation, and (3) to understand the physical mechanisms responsible for any differences from Clausius-Clapeyron scaling. The project will focus on changes in extreme precipitation over North America. A novel aspect of the project will be the application of synoptic analysis of extreme precipitation composites in addition to the use of statistical analysis and climate diagnostic methods.

The proposed research is relevant to both the overall objectives of Climate Change Data and Detection Program and to the specific foci that have been identified for FY09 proposals, which include an emphasis on extreme events and the utilization of existing simulations by multiple models. The improved understanding of expected changes in extreme precipitation that is expected to result from this project can help society anticipate and prepare for possible changes in the frequency and intensity of river flooding, which has a major impact on life and property and will likely be one of the more important impacts of climate change.